

Rapid Concentration for Improved Detection of Microbes in ISS Potable Water, Phase II

Completed Technology Project (2016 - 2021)



Project Introduction

Providing a reliable supply of safe drinking water is a critical requirement for space exploration. Systems that provide recycled treated water aboard the International Space Station, and that will supply water aboard future spacecraft, are inherently complex and can be susceptible to biofilm formation and microbial contamination. Further, it has been noted that pathogenicity and virulence of microbes can increase in microgravity environments. These factors, along with the high consequence of sickness in the remote space environment, make rapid, reliable methods of detecting microbes at low levels a critical need. Rapid microbiological detection systems have taken dramatic steps forward in the last two decades and today detection of even a single organism is possible in less than one hour. Unfortunately, development of rapid detection methods has far outpaced development of sample concentration and preparation techniques, which are necessary to enable detection of low microbial concentrations in drinking water. Currently, without sample concentration, rapid detection techniques alone produce results that are hundreds to thousands of times less sensitive than the minimum desired detection limit for microbial water contaminants. InnovaPrep proposes development of a rapid microbial concentration system designed for use aboard the International Space Station. The system will concentrate microbes from up to 5 Liters of potable water into volumes as small as 200 μ L, providing concentration factors as high as 15,000X. It will be based on technologies developed and commercialized by InnovaPrep, but will contain innovations to allow for operation in microgravity. Large volumes of potable water are processed through a hollow fiber membrane filter concentration cell as microbes are captured within the lumen of the fibers. Following capture, the microbes are efficiently eluted using a novel Wet Foam Elution process and then delivered to a rapid detection system for analysis.

Anticipated Benefits

In the proposed format, the Hydrosol Concentrator for microgravity (HC-ug) will have direct application to the microbial water monitoring needs of the International Space Station & all crewed national and international space agencies and missions. Further, because small sample sizes are a requirement of rapid microbial detection systems, & because required microbial detection limits for drinking water are extremely low, this need is not anticipated to decrease in the near future. The WetLab-2 initiative will directly benefit from the HC-ug program, & they will be able to spin off additional tools using this technology. In addition to the needs of the space agency community, many components of the technology developed in the proposed project will also have application to USG earth-based microbial water monitoring applications. The small, zero-power format of the HC-ug system will lend itself to development of fieldable concentration devices for DoD water monitoring needs in austere environments. It will be applicable to field sampling and analysis during outbreak investigations in remote locations, or when sending samples to a



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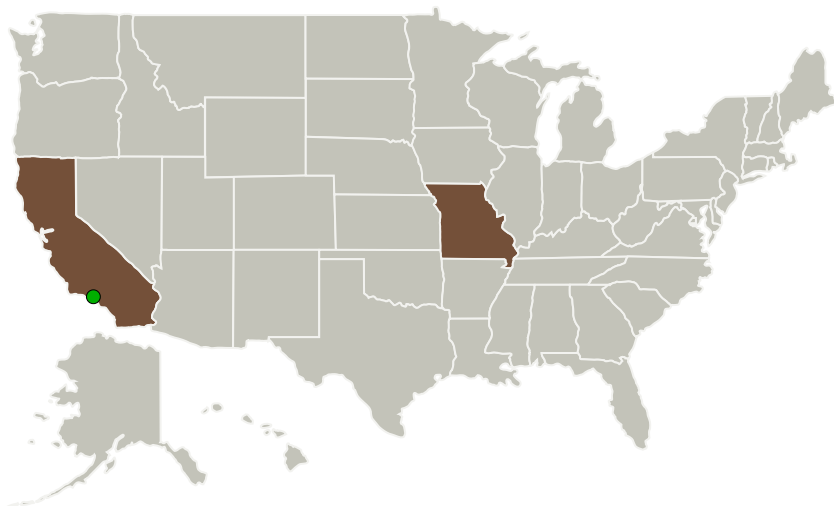
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laboratory is not acceptable. Water monitoring in developing countries is an important need that could benefit greatly from low-cost, fieldable kits that allow for delivery of a concentrated sample to rapid detection kits. InnovaPrep is already working to identify aligned opportunities within US DoD through DTRA's SOCOM handheld sample prep prgmThe proposed Phase II project will perfect elution fluid formulation and development of our fluid canisters, and improve manufacturing techniques for elution canisters and handheld devices for use in an InnovaPrep biological concentrator for use in a microgravity environment. We expect that the improved performance of our space systems will provide commercial potential for InnovaPrep. The feasibility, usefulness, and market need for commercial InnovaPrep systems that use canned elution fluids and/or hollow fiber concentration has already been demonstrated. As of December 2015, over 150 instruments have been sold or leased worldwide that use our canned fluids, and nearly 10,000 fluid canisters have been manufactured here and sold to those customers. Over 50,000 concentration cells have been sold. This initial success includes early adoption by DoD in the Joint Biological Tactical Detection System (JBTDs), which is now in the early manufacturing and design (EMD) phase. When completely deployed by 2019, over 4500 of those systems will be in daily operation, using up to 4.5 million canisters per year. InnovaPrep has also made significant early progress in commercial markets, and customers include global market leading companies in biopharmaceuticals, commercial products manufacturing, animal health, food & beverage, and other applications of industrial microbiology and life sciences R&D. The sales to these customers are expected to exceed the sales to DoD.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

InnovaPrep, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Lynn M Torres
Carol R Lewis

Principal Investigator:

Andrew E Page

Co-Investigator:

Andrew W Page

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Organizations Performing Work	Role	Type	Location
InnovaPrep, LLC	Lead Organization	Industry	Drexel, Missouri
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Missouri

Project Transitions

▶ **April 2016:** Project Start

✓ **January 2021:** Closed out

Closeout Documentation:

- Final Summary Chart PDF(<https://techport.nasa.gov/file/139456>)

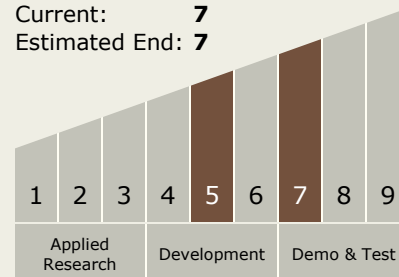
✓ **January 2021:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/139457>)

Technology Maturity (TRL)

Start: **5**
Current: **7**
Estimated End: **7**

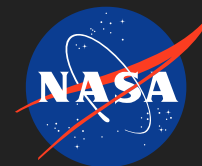


Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System

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Images



Briefing Chart Image

Rapid Concentration for Improved Detection of Microbes in ISS Potable Water, Phase II
(<https://techport.nasa.gov/image/129286>)



Final Summary Chart Image

Rapid Concentration for Improved Detection of Microbes in ISS Potable Water, Phase II
(<https://techport.nasa.gov/image/126201>)